古脊椎动物与古人类
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鋸齿龙类在我国的初次发現*

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一 般 介 紹

石千峯地层在我国华北相当发育,但由于过去未曾发现过能够鉴定的化石材料,因而关于它的地質年代問題,多年来一直是有关学者們的爭論焦点。然而,近年来,随着地层工作的开展,各地已开始有了化石記录;虽然材料还不很多,但对其地質年代的鉴定却有重要的意义。

在此以前,从石千峯地层中获得的脊椎动物化石都很零星、破碎,因而都未曾作出属种鉴定。1959年,王择义在山西保德石千峯地层中获得了一些骨化石。这些骨化石仍因过于破碎,不能作出詳細鉴定。但从化石的一般性質及其保存情况来看,似乎有希望在此获得更好的材料。

1960年,孙艾玲偕同王择义和技工王兴珍等前往保德又作了一次調查。他們不仅証实了王择义发現的化石地点,并发掘到了一批部分相連的两具脊椎动物骨架。这是迄今在石千峯地层中发現的最好的脊椎动物化石。本文便是这批材料的記述。

这批化石是苏有倫等同志修理、装架的;文中插图是胡惠清同志描繪的;图版是王哲夫同志摄制的。作者在此表示感謝。

据孙艾玲的剖面,含脊椎动物化石的地层层序如图1所示。剖面測自黃河南岸保德县城至花园間一段。地层順序自下而上可分为:

V. 二馬营統:土紅暗紅砂岩。
IV. 石千峯統上部(和尙沟阶):土紅色泥岩和砂質泥岩。
III. 石千峯統中部(刘家沟阶):土紅淡紫紅色砂岩。
II. 石千峯統下部(孙家沟阶):暗土紅色泥岩与砂岩互层。約40米。
II—IV. 石千峯統。
I. 石盒子統:暗紫色杂色砂岩。

脊椎动物化石产自第II层頂部(图1中以⊗表示),相当于孙家沟阶,属石千峯統下部。两具骨架分别采自两相距約7—8米的地点。这两地点显然属于同一层位。

这两具骨架代表两个个体,但属于同一属种,归鋸齿龙目(Pareiasauria)。鋸齿龙类是一类个体比較碩大、构造比較粗笨的低等爬行动物,主要生活于二迭紀。目前已知的材料以南非为多。我們的标本就其一般构造来看,与南非的属类比較近似,但仍有好些主要特征上的差异,应另为一新属,代表該类动物在中国的首次发現。

* 7月2日收到。

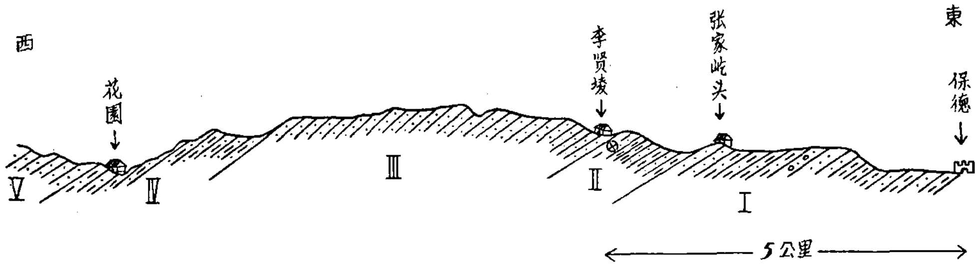


图1. 保德县城至花园間沿黄河南岸地层剖面(依孙艾玲)
⊗化石层位 (Geological section of vertebrate-bearing bed, after Sun. ⊗, fossil horizon)

标 本 記 述

鋸齿龙目 (Pareiasauria) Broom 1913

鋸齿龙科 (Pareiasauridae) Cope 1896

石千峯龙属 (*Shihtienfenia*), 新属

属的特征: 見下述属型种的特征。

二迭石千峯龙 (*Shihtienfenia permica*), 新种

正型标本: 一具不完整的骨架。包括大約20个脊椎, 2个肩胛骨, 2个鎖骨, 左烏喙骨和前烏喙骨, 两个肱骨, 两个腸骨、坐骨和恥骨, 以及一些神經棘和脊椎碎片。野外編号: 60.111 B。本所标本登記号: V. 2717。

副型标本: 11个背椎以及一些脊椎碎片。野外編号: 60.111 A。本所标本登記号: V. 2718。

这两具骨架保存都不完整。副型标本风化更甚, 有些骨头在野外都不能安全取出。正型标本保存較好。关于这两具骨架的缺失部分, 可能原来业已风化破坏, 也可能在野外尙未找見。

层位和产地: 上二迭統。山西保德李賢坡。

特征: 个体大。椎体两端深凹, 脊椎上有很发育的、横向的前后关节突。背椎部分的間椎体发育很好。椎下窝 (hypantrum) 和椎下突 (hyposphene) 微弱, 但可看出。荐椎6块。肩胛骨狭而細长。烏喙骨和前烏喙骨骨化一起。鎖骨粗壮。肱骨大, 近、远两端強烈扭轉, 近端部分甚扩张, 无內髁孔。腸骨不向前方傾斜, 上緣平直, 上緣寬于下緣。恥骨和坐骨融合一起。

脊椎 由于正型标本以及副型标本的脊椎曾于发掘后多少已經攪乱, 因而除那些相連的脊椎外, 其他脊椎的前后次序难于确切肯定。在正型标本中, 图2所示的5个相連的脊椎显然是紧挨荐部(图3)前面的荐前椎。除此以外的脊椎的排列次序是按照它們的构造来排列的, 它們可能是: 4个頸椎, 4个前部背椎和1个尾椎。但它們确切位置不易肯定(图版 II)。在副型标本中, 7个相連的脊椎甚有可能代表中后部背椎; 而其他4个脊

椎，三个可能为前部背椎，另一个为尾椎（图 4）。 同样地，这些脊椎的正确位置也不能肯定。

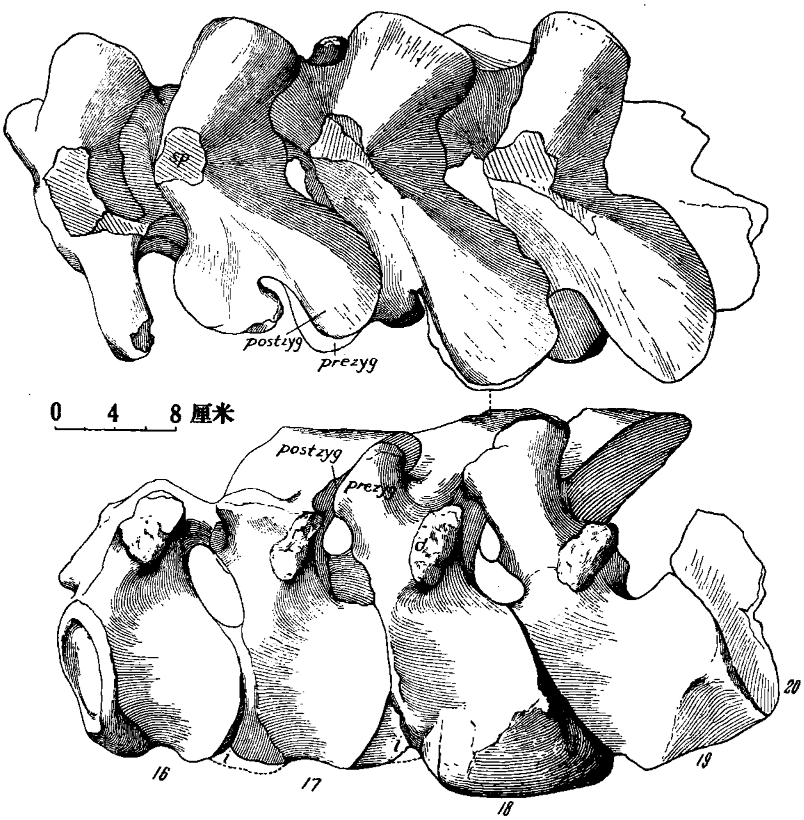


图 2. *Shihtienfenia permica*, gen. et sp. nov. V. 2717. × 1/6
正型标本第 ？16—20 个荐前椎背視(上)和左側視(下)。簡字如一般采用者。下同。
(?16th to 20th presacral vertebrae of type in dorsal, upper, and left side, lower, views. Abbreviations as usually adopted, same as in the following Figs.)

正型标本前部 4 个单个的脊椎都不完全。第一个仅由神經孔周围部分为代表。第二个和第三个則仅只椎体部分保存。第四个可能是后部頸椎或甚至为前部背椎。这个脊椎仅只保存了椎体以及右側部分。所有这几个脊椎保存的椎体都較短，两端深凹，两側輕微收縮，但椎体的腹面都較圓寬，仅只第三个腹面有点稜嵴。

頸椎之后为 4 个单个的前部背椎(前面两个仍原生相連一起，最后一个粘附着一部分后面脊椎的椎体)，保存較好。相連的第一、二两个甚可能代表第十一到十二个或十二到十三个荐前椎。这两脊椎虽然业已破損，但其一般构造大部仍可看淸。前視可以看到一个微弱的椎下窝，并在椎下窝和神經孔之間，有一个微弱的角尖状的构造。这个构造在其他同类动物中从未見过，并在第四个脊椎上便消失了。前部背椎的椎体都仅稍許側扁，但有很傾斜的狹长的横突关节面。 最后一个脊椎的横突較短，表示它是一个相当靠近后部的背椎。

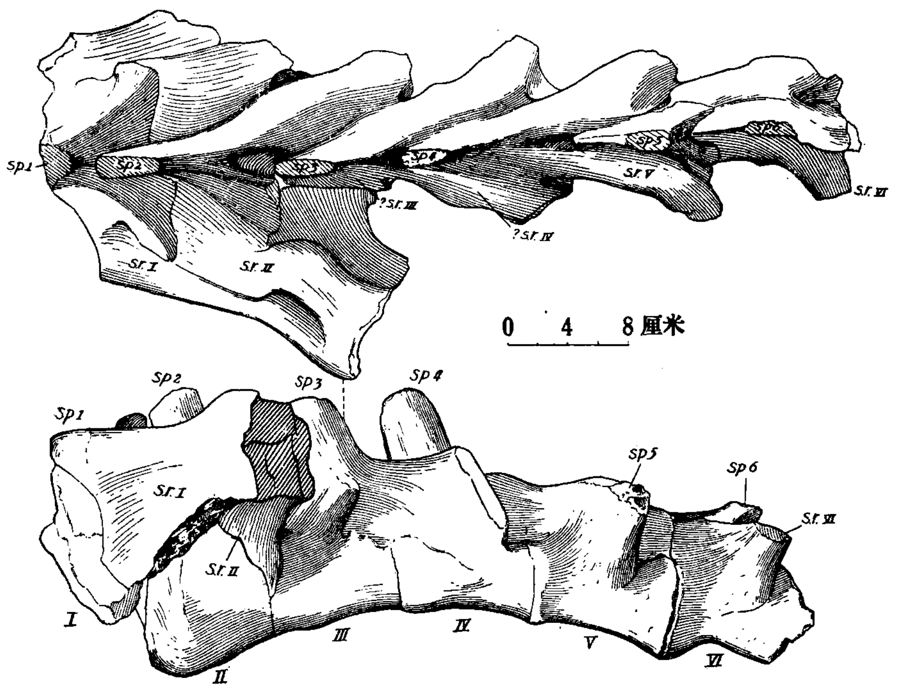


图 3. *Shihtienfenia permica*, gen. et sp. nov. V. 2717. × 1/6

正型标本荐椎背视(上)和左側視(下)。
(Sacrum of type in dorsal, upper, and left side, lower, views)

此后为 5 个相連的脊椎。这几个脊椎多少保存完整,可能代表紧挨荐椎前部的背椎,即第十六至二十个荐前椎。在这 5 个脊椎中,前面几个保存更为完整,但神經棘都已破損。这些脊椎的前、后关节突发育都很粗壮, 左側两个和右側三个的关节面都还原生地連接着。关节突短,有一个椭圓形的关节面。后面 3 个脊椎椎体的腹面都不太側扁,而前面两个的則形成了一条尖銳的稜嵴。这些脊椎間的間椎体都有保存。

副型标本的脊椎对正型标本起了很大的补充作用。保存的第一个脊椎(甚为破損)可能代表第十一或十二个荐前椎,椎体业已破缺。与此相連的第二个脊椎的椎体虽已殘破,但显然非常側扁。这个脊椎的神經棘保存很好,外形长而纖細。这两脊椎左側的前、后关节突都可清楚看到。此后为一单个的脊椎。这个脊椎我們揣測可能是位于上述两脊椎之后的,它的椎体甚短。再后为 7 个相連的脊椎。这 7 个脊椎已強烈錯动,但它們的一般构造还可清楚看出。这些脊椎的椎体腹面都非常側扁,并各有发育很好的間椎体,可能代表第十一到十七个后部背椎。它們的神經棘都保存很好,棘长而纖細,前、后緣多少成尖銳的稜嵴,棘的远端仅只稍許增厚。 同样地,这些脊椎的右側前、后关节突大多也都保存很好。

骨架的最有意思部分是正型标本中保存的荐椎(图 3)。 第一荐椎业已破損,但其第一荐肋仍可看到。 因此,整个荐部的脊椎数目应为 6 个,而不是大多鋸齿龙那样的 4 个。

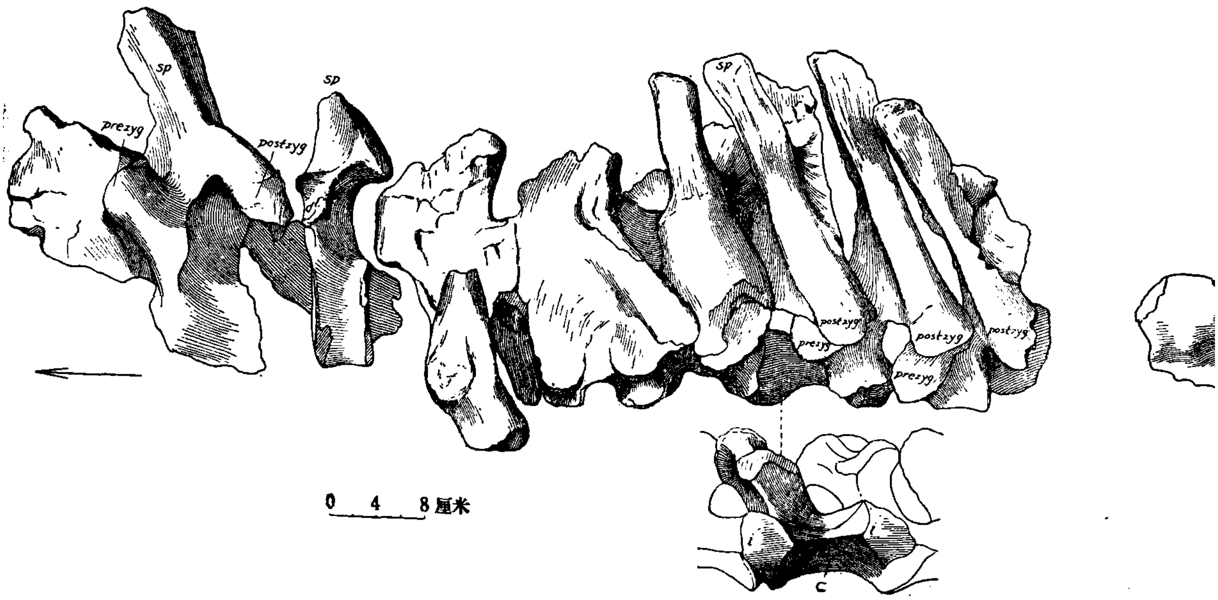


图 4． *Shihtienfenia permica*, gen. et sp. nov. V.2718. × 1/6

副型标本左侧视(上)和其中一个脊椎腹视(下)。箭头表示前面。

(Left side view of paratype with one vertebra in ventral view. Arrow points the front)

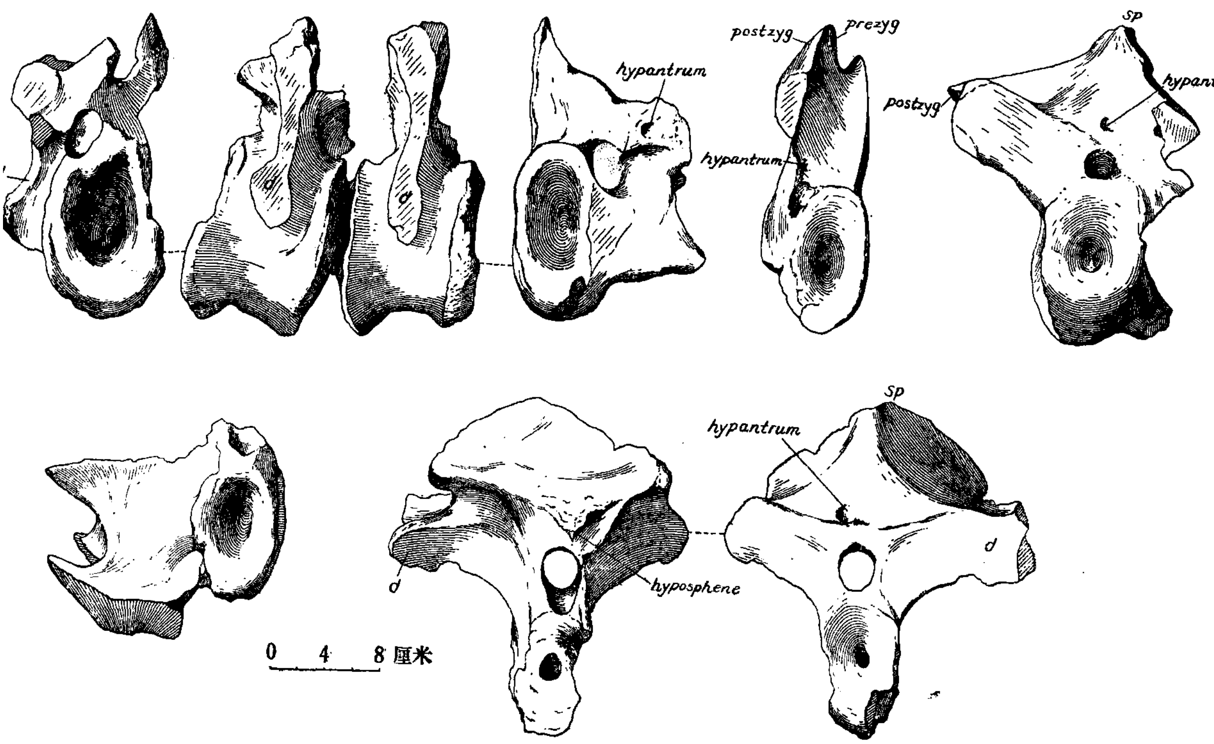


图 5． *Shihtienfenia permica*, gen. et sp. nov. V. 2717, V. 2718. × 1/6

上，从左至右：正型标本第？十一—十二个荐前椎后视，左侧视和前视；第？十三个荐前椎前视；第？十四个荐前椎前视。下左，正型标本的一个后部颈椎(?)前视；下中和右，副型标本第？十三个荐前椎后视和前视。

(Upper, from left to right: ?11th to 12th presacral vertebrae of type in posterior, left side and anterior views; ?13th presacral vertebra of type in anterior view; ?14th presacral vertebra of type in anterior view. Lower left, ?posterior cervical vertebra of type in anterior view; lower middle and right, ?13th presacral vertebra of paratype in posterior and anterior views)

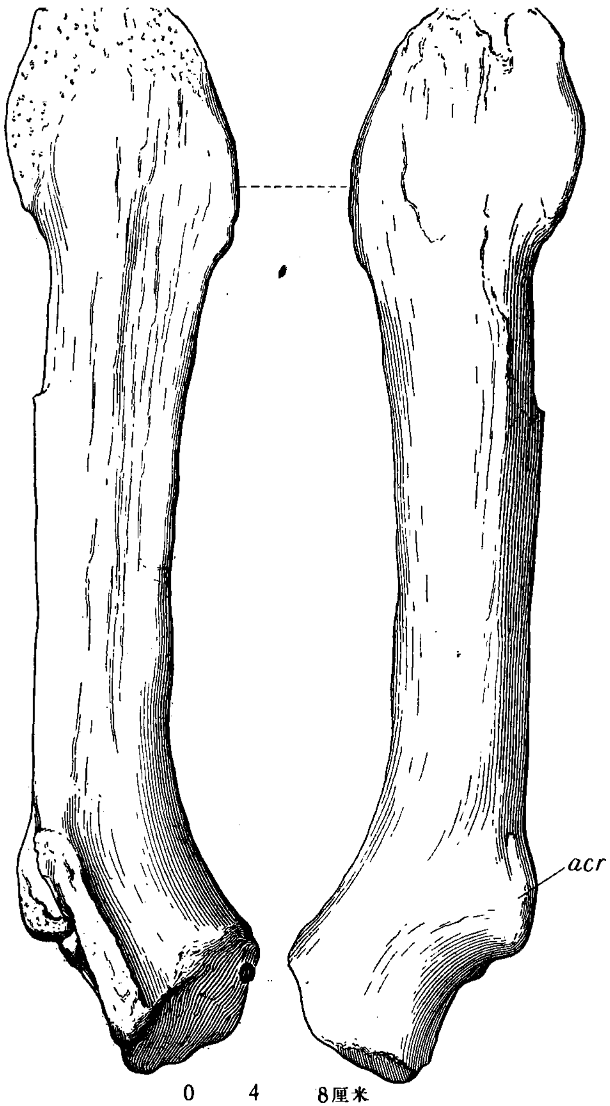


图 6. *Shihtienfenia permica*, gen. et sp. nov. V. 2717. ×1/6

正型标本右肩胛骨内視(左)和外視(右)。

(Right scapula of type in inner, left, and outer, right, views)

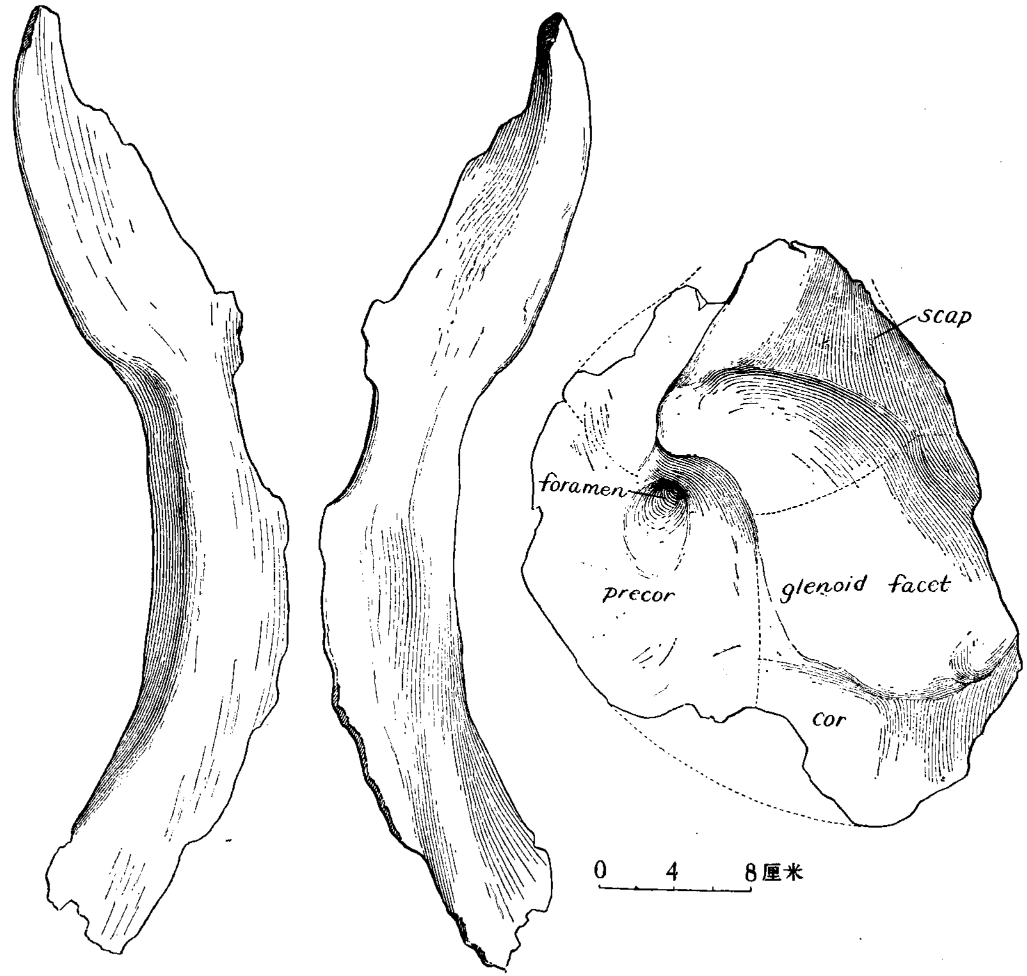


图 7. *Shihtienfenia permica*, gen. et sp. nov. V. 2717. ×1/6

左,正型标本左鎖骨外視和内視;右,正型标本部分左肩带外視。

(Left, left clavicle of type in outer and inner views; right, part of left pectoral girdle of type in outer view)

荐椎的椎体都較狭窄，但不象上述最后两个脊椎那样側扁。荐椎的体积由前往后递次变小，但其长度并不減短，因而后面几个荐椎的外形看来比較伸长。所有荐椎都牢固地連接在一起。第二、三、四个的神經棘大部保存，棘較长，但薄而側扁。左側荐肋大多保存，其中第一、二两条还完整地与左側腸骨的前上緣相連，第五荐肋的縫合虽已断开，但仍可粘連一起。当中两条荐肋业已破断，但仍留有基部痕迹。整个荐部的长度約 260 毫米。荐部側視略有弯曲。

尾椎仅只两块保存，一为正型标本的，另一为副型标本的。这两脊椎都不完整，无需仔細描述。

总的說来，这两串脊椎的一般性質都很一致，可以肯定属于同一属种。但由于它們保存不完整，因而除荐椎部分外难于确定脊柱各部分脊椎的正确数目。然而，甚可能和大多鋸齿龙类一样，共有 20 个左右荐前椎，其中有 5 个(或稍多)是頸椎。从我們标本的发育很好的間椎体和数目增多的荐椎等特征来看，可以揣測它是一种比較原始的鋸齿龙。脊椎上前、后关节突的強壮发育，这是大多鋸齿龙中常見的性質。我們标本的神經棘都比較纤薄，这似乎說明它的皮骨甲片可能不太发达。

除此之外，正、副型标本各还有一些脊椎部分的碎片，这些碎片都不能与上述脊椎粘連，說明另外还有一些脊椎我們未曾找到。

在这些破碎的材料中，有 3 个保存較好的正型标本的神經棘和 1 个副型标本的神經棘及其前、后关节突。此外，还有一些正型标本的背部肋条碎片。

肩胛骨　左右两側的肩胛骨都有保存。右側的完整，仅只远端部分稍为破損。左側的也近于完整，只是它的近端部分业已断开而粘附在烏喙骨和前烏喙骨上了，并且远端部分也有些破損。肩胛骨直而狹，两端部分仅只輕微扩张，这些性質与已知的鋸齿龙类都甚不同。骨头中度厚，近端部分则較厚。肩突（acromion）微弱，位置低。右肩胛骨的远端部分有点异常，我們怀疑生活时是否有軟骨的上肩胛骨（suprascapula）存在。右肩胛骨全长 650 毫米，左肩胛骨估計全长約 640 毫米。右肩胛骨肩突处寬 160 毫米，远端寬 130 毫米，近端寬 71 毫米。

烏喙骨和前烏喙骨　烏喙骨和前烏喙骨仅有左側保存。这两骨头与左肩胛骨的近端部分骨化一起，下緣部分破損。烏喙骨和前烏喙骨以及它們与肩胛骨之間的骨縫模糊，图 7 中用虛綫表示了它們的界限。烏喙孔大，位于靠近肩胛骨下端的边緣。肩臼寬而浅，由肩胛骨和烏喙骨共同形成。烏喙骨和前烏喙骨的前后最大长度为 270 毫米。

鎖骨　左右两鎖骨都有保存。左边的近于完整，而右边的仅其下部为代表。这两骨头的构造与其他鋸齿龙类的很近似，只是較比粗壮。每一鎖骨两端間的平直长度为 495 毫米。外形稍微弯曲。

間鎖骨和匙骨都沒保存，因而不能完整地复原肩带。但就其保存部分来看，业已显示一般构造情况(图版 I, II)。

肱骨　左側肱骨几近完整，右側仅只近端部分为代表。

肱骨粗大，全长約 540 毫米(从图上量得的 *Pareiasaurus serridens* 的肱骨全长約为 450 毫米，*Pareiasuchus péringueyi* 为 345 毫米，*Propappus rogersi* 为 267 毫米)。近端強烈扩张，最大寬度为 290 毫米(上述 3 属的相同长度分别約为 259，184 和 178 毫米)。

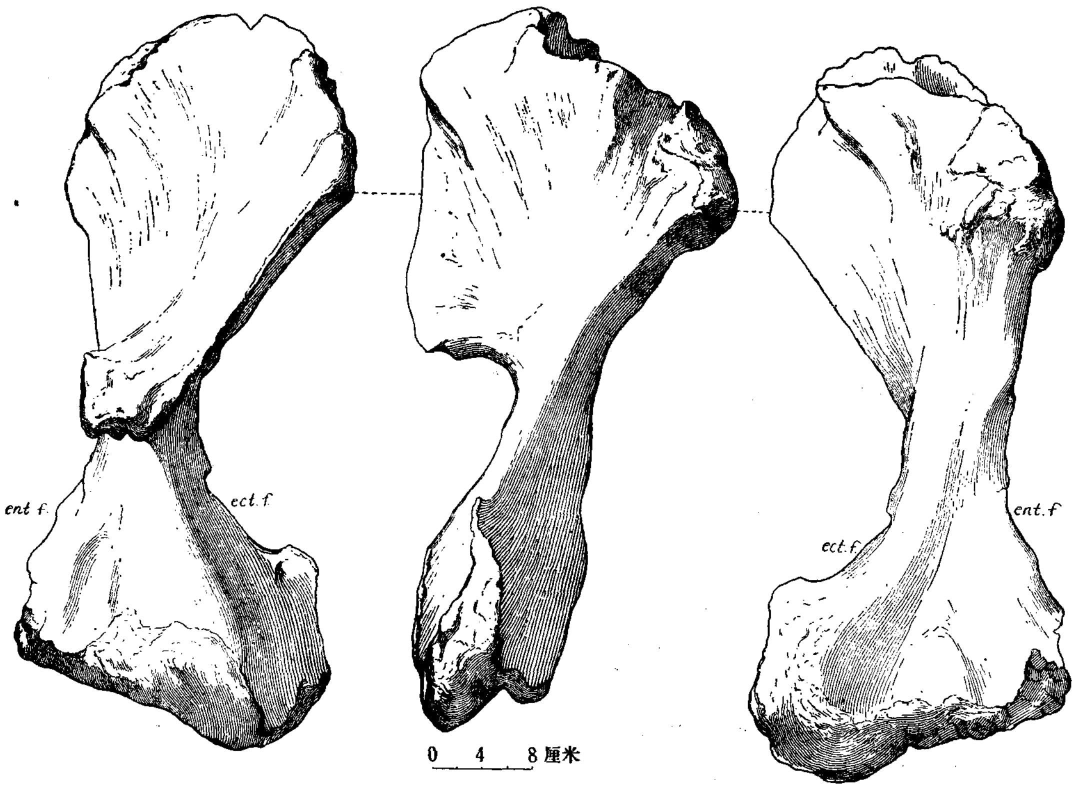


图 8. *Shihtienfenia permica*, gen. et sp. nov. V. 2717. × 1/6

从左至右:正型标本左肱骨前視,背視和后視。

(From left to right: left humerus of type in anterior, dorsal and posterior views)

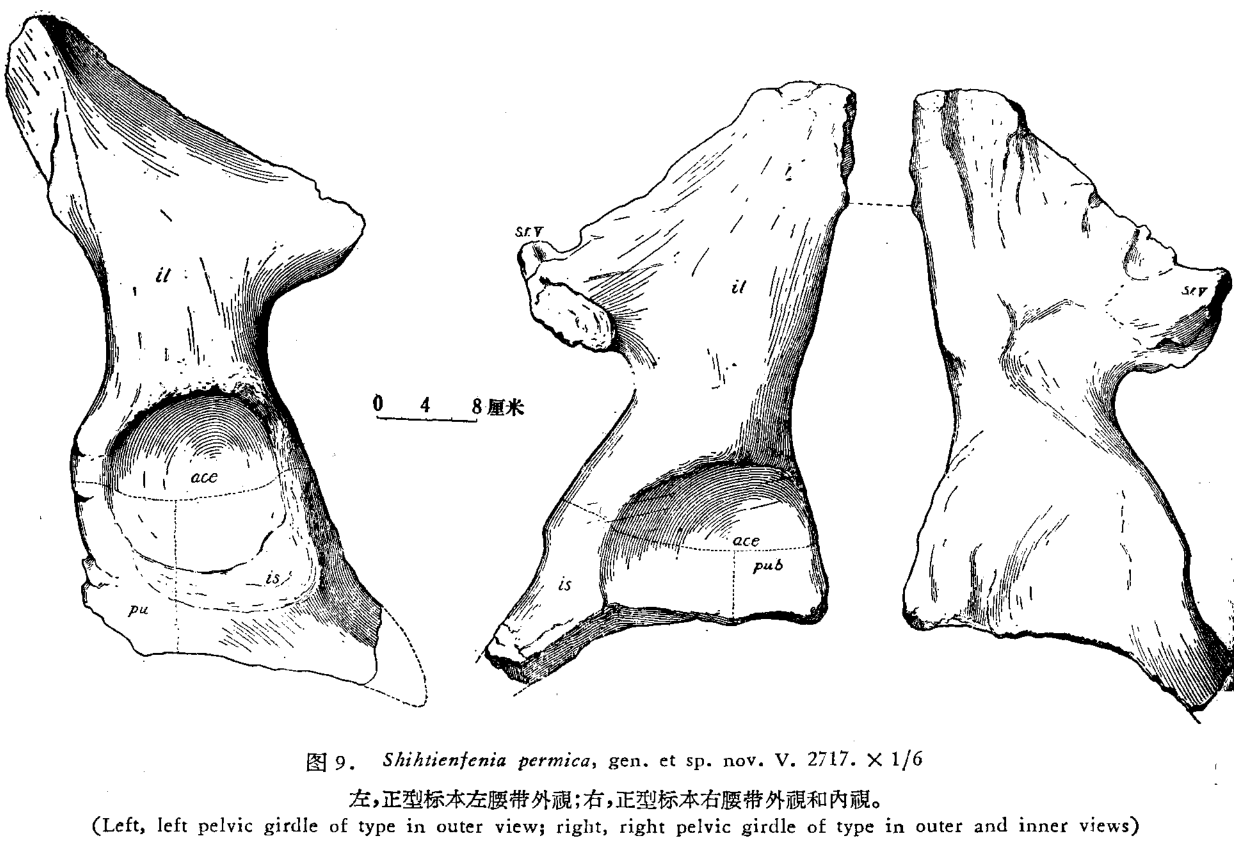


图 9. *Shihtienfenia permica*, gen. et sp. nov. V. 2717. × 1/6

左,正型标本左腰带外視;右,正型标本右腰带外視和內視。

(Left, left pelvic girdle of type in outer view; right, right pelvic girdle of type in outer and inner views)

远端部分不甚扩张，最大寬度为 250 毫米(上述 3 属的相同长度分别約为 230, 140 和 175 毫米)。中部強烈收縮，直径平面为 58 × 75 毫米。

肱骨两端強烈扭轉，約成 40 度。这个度数甚小于 *Pareiasaurus serridens* 的度数，而大于 *Propappus rogersi*。在近端关节髁处，有一道明显的凹沟，这与 *Propappus rogersi* 的甚似。据 Broom 推测，这很可能是长軟骨衬垫的。三角肌稜嵴 (delto-pectoral crest) 的形状也和上述种类的相似，并也有明显的疖結。无外髁孔 (ectepicondylar foramen)，但可明显地看出有一条外髁沟，沟的位置較高。无內髁孔 (entepicondylar foramen)，因而与內髁孔发达的 *Propappus rogersi, Pareiasuchus péringueyi* 和 *Pareiasaurus serridens* 等都不相同。尺骨和挠骨的关节面粗壮，彼此分开。

腰带　左右腰带都有保存。左边的几乎完整，右边的坐骨和恥骨的下緣破缺。和其他鋸齿龙类的一样，腰带的三块骨头完全融合一起。我們标本的腰带的主要特征是腸骨上緣的长度大于耻骨和坐骨所組成的下緣长度。

腸骨上緣的长度左側为 320 毫米，右側为 325 毫米 (*Pareiasaurus serridens* 的为 367 毫米，*Pareiasuchus péringueyi* 为 225 毫米，*Propappus rogersi* 为 190 毫米)。左耻骨和坐骨的下緣长度为 280 毫米。腰带的最大长度为 550 毫米 (*Pareiasaurus serridens* 的为 615 毫米)。左髖臼的寬度为 170 毫米 (*Pareiasaurus serridens* 的为 155 毫米，*Pareiasuchus péringueyi* 的为 97 毫米，*Propappus rogersi* 为 115 毫米)。

腸骨　腸骨組成腰带的最大部分。上緣平直，不向前傾斜。这一特征与 *Pareiasaurus serridens* 和 *Pareiasuchus péringueyi* 的不同，而与 *Propappus rogersi* 的甚似。腸骨的較长的上緣可能与荐椎的数目增加有关。左側的第一、二荐肋連合一起，与腸骨的前端关連。左側的第三、四条荐肋虽已破缺，但仍可看到它們的近端部分的痕迹。第五荐肋左右两側保存都很完全，并还看得出与腸骨的关节情况。右側荐肋除上述的第五条外，其余的保存都不完整，但仍可看出有如左側的排列方式。腸骨在髖臼之上驟然收縮，稍后，又复扩张。两側腰带中的腸骨、耻骨和坐骨之間的縫合綫都較模糊，但可能有如图 9 所示。

髖臼 (acetabulum) 圓而較深，上边緣稍微外突。

恥骨　耻骨較小，仅部分参与髖臼的組成。右耻骨部分毁坏，左耻骨保存較好。耻骨孔小而不显。两耻骨的前下緣都沒保存，因而未見左右耻骨的联合。

坐骨　坐骨的外状頗为特殊。从两側坐骨后部的破損部分判别，似乎具有一个短的尖端。这一性质与 *Pareiasaurus serridens* 和 *Propappus rogersi* 的甚为不同，而与 *Pareiasuchus péringueyi* 的近似。

由于荐部的骨头略有破損，并且右腰带的保存也不很完整，因而在我們的标本中不可能看到腰带部分原生的联合情况。总的說来，我們标本的腰带无疑是与鋸齿龙科的相近，但有它自己的一些特殊特征，諸如具有較长的腸骨上緣和坐骨尖端等。从腸骨上緣不向前傾斜而是平直的这一性質来看，我們的标本与 *Propappus* 属最为近似，而与本科其他属类較远。

在我們的标本中未曾发現有皮骨甲片，这可能是因为未曾保存或仅由一些过于破碎的骨片为代表。从一般鋸齿龙类的构造推測，我們的标本可能也是一类披有縱长甲片的动物。

比 較 討 論

虽然，本文記述的标本沒有头骨，并且其头后骨架保存也不十分完整，但从保存部分的特征来看，还是可以作出一个可靠的鉴定来。我們标本的特殊构造的脊椎，具有間椎体，以及上肢肱骨上的特征和更重要的腰带上的特征等，都和鋸齿龙类的属类很近似，显然应归入鋸齿龙科，杯龙上目（Cotylosauria)。

从上述一系列的特征来看，我国的标本与本类任何已知属类都不相同。因为沒有头骨和牙齿保存，因而不能与 Haughton 和 Brink（1954）所列的本科的 11 个属进行完全对比，但即便从其个体大小比較，也可与其中的 *Anthodon, Brachypareia, Bradysaurus, Dolichopareia, Embrithosaurus, Nanoparia, Nochelesaurus* 等属区别开来。同样地，*Pareiasaurus* 属和 *Pareiasuchus* 属也因为腸骨的形状不同而与新属标本有别。与我們标本最接近的是 *Propappus* 属，但它們的腰带和肱骨构造仍然不同。

与南非以外的其他属类比較，苏联的 *Scutosaurus* 是最相近的一屬。它們不仅一般外形近似，并且个体大小也相若，但比較起来，我們的标本比它更大。据 Hartmann-Weinberg（1937），苏联标本的肱骨只有 300 毫米长，并且比較平扁，两端扭轉也不厉害。同时，中国标本的具有 6 个荐椎以及腰带的形状等，也与 *Scutosaurus* 不同。

显然，本文記述的标本甚有可能代表鋸齿龙类中的一新类型。我們建議命名为二迭石千峯龙（*Shihtienfenia permica*)，新属，新种。如上所述，本属动物与南非的 *Propappus* 属和苏联的 *Scutosaurus* 属最为近似。然而，从二迭石千峯龙的荐椎数目增加，长而平直的腸骨上緣，以及肱骨上缺乏內髁孔等特征来看，它似有可能代表鋸齿龙目中的一个新科。

在文献的应用中，我們注意到了 Broom 曾从腰带的形状出发，認为 *Propappus* 属为 *Pareiasaurus* 属的异物同名。对此，我們并不認为完全正确，因为，从他自己的文章記述中，可以看出(1903，1912)，它們的腰带构造的确是不同的。

二迭石千峯龙是中国第一次发現的鋸齿龙目的动物。上已提及，該标本产自下石千峯統的頂部。这个产化石地层的年代，因此可以肯定为晚二迭世。这个結論是与李星学(1963，1963A)通过古植物的研究所得的結論是一致的。但是，必須注意的是，这里記述的脊椎动物化石只是产自石千峯統的下部，而在林遮峪的含化石的层位(可能为石千峯統的上部)中知道的东西还很少，因而至少目前我們还不能把整个石千峯統都划归晚二迭世。同时，在山西我們迄今还未发現眞正的水龙兽或其相近的属类，所以，有关中、上部石千峯地层的时代問題，应該有待于今后发現更多的材料来解决。

綜观本文以及其他二、三迭紀脊椎动物化石的研究，在我国二、三迭紀地层中，迄今至少已有 6 个脊椎动物化石层位。这些层位都可分别与南非和苏联的相当层位对比。今且列表如下頁。

在我国三迭紀地层中，迄今已知的脊椎动物化石主要有云南祿丰龙动物羣，山西中国肯氏兽动物羣，以及新疆的水龙兽和加斯馬吐龙等，材料相当丰富。但是，有关二迭紀的材料，知道却还很少。这次石千峯龙的发現，預示在我国二迭紀陆相地层中，甚有希望发現丰富的脊椎动物化石。

时代	南非	苏联	中国
三	Cave sandstone, Red Beds		祿丰龙(并有卞氏兽)
	Ictidosaurian Zone		
	Molteno Beds		
迭	*Cynognathus* Zone B	Zone VII	
	Cynognathus Zone A (with *Erythrosuchus*)	Zone VI	中国肯氏兽(并有山西鼉)
紀	*Procolophon* Zone		河套兽(*Ordosiodon*, 林遮峪)
	Lystrosaurus Zone	Zone V	水龙兽(并有加斯馬吐龙)
二	*Cisticephalus* Zone	Zone IV B (with *Scutosaurus*)	石千峯龙
	Endothiodon Zone	Zone IV A	
迭	*Tapinocephalus* Zone	Zone III	迷齿类
		Zone II	
紀		Zone I	

参　考　文　献

(Bibliography)

李星学，1963A：中国晚古生代陆相地层。全国地层会議学术报告汇編。科学出版社，105—150。

Broom, R., 1903: On an almost perfect skeleton of *Pareiasaurus serridens* Owen. Ann. S. Afr. Mus., **4**(2): 123—138.

——————, 1912: On a New Species of *Propappus*, and on the pose of the *Pareiasaurus* Limbs. Ann. S. Afr. Mus., **7**(5): 323—331.

——————, 1935: Notes on Some Species of Pareiasaurian Reptiles. Ann. Trans. Mus., **18**(1): 37—51.

Broom, R. and Haughton, S. H., 1913: On the Skeleton of a New Pareiasaurian (*Pareiasuchus péringueyi*, g. et sp. nov.). Ann. S. Afr. Mus., **12**(1): 17—25.

Hartmann-Weinberg, A., 1937: Pareiasauriden als Leitfossilien. Prob. Paleon. **2—3**: 649—703.

Haughton, S. H., 1913: On a new species of *Propappus*. Ann. S. Afr. Mus. **12**(1): 36—39.

Haughton, S. H. and Brink, A. S., 1954: "A Bibliographical List of Reptilia from the Karroo Beds of Africa". Palaeon. Afr. **2**: 9—16.

Lee, H. H., 1963: *Fossil Plants of the Yuehmenkou Series, North China. Paleon. Sinica, Whole No. 148*, New Ser. A. No. 6, 68—85.

ON A NEW PAREIASAUR FROM THE UPPER PERMIAN OF SHANSI, CHINA

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INTRODUCTION

In Shansi the permo-triassic beds known as the Shihtienfeng Series are barren of determinable fossils and no vertebrate remains were found, so that their geological age has been a subject of debate for a long time. Recently, however, various fossils have been reported, although poorly known, from many places, particularly vertebrate remains. It is possible now to give a rather conclusive view of the age of the series from the study of the vertebrate fossils.

In 1959 Mr. T. Y. Wang has brought to the laboratory a few fragments of sure fossil bones from the Shihtienfeng Series of Paote, N. W. Shansi. They are too fragmentary and indeterminable but show without any doubt that the beds are fossiliferous and hopeful to make further investigation.

In 1960 A. L. Sun accompanied by T. Y. Wang and technician S. C. Wang to the Paote area for further exploration. They were able not only to confirm the site with vertebrate remains of T. Y. Wang but also excavated a number partly articulated skeletons which are described in the present paper.

According to Sun, the geological sequence of the vertebrate-bearing formations are showing the figure 1. It was taken west of the Paote city to Huayuan along the south bank of the Huangho. The following stratigraphical units can be recognized:—

V. Ehrmayin Series. Earth red and dark red sandstones.

IV. Upper Shihtienfeng Series, the Hoshangkou stage, earth red mudstones and sandy clays.

III. Middle Shihtienfeng Series, the Liuchiakou stage, earth red and light purplish red sandstones.

II. Lower Shihtienfeng Series, the Sunchiakou stage, dark earth red clays and sandstones intercalated. About 40 meters.

II-IV. Shihtienfeng Series.

I. Shihotze Series. Dark purplish and varigated sandstones.

The locality with vertebrate remains, as shown in the figure by a encicled cross is stratigraphically on the top of the II, the Sunchiakou stage, and thus belongs to the lower Shihtienfeng Series. There are two partially articulated skeletons have been unearthed withing an area of 7—8 meters and apparently belong to the same fossiliferous horizon.

DESCRIPTION

Order Pareiasauria Broom 1913

Family Pareiasauridae Cope 1896

Shihtienfenia, gen. nov.

With the diagnosis of the type species described below.

Shihtienfenia permica, sp. nov.

Type: An incomplete skeleton without head including about 20 vertebrae, both

scapulae, both clavicles, left coracoid and precoracoid, both humeri, both ilia, ischia and pubes, and a number of fragmentary specimens, mostly dorsal spines and other fragments of vertebrae. Field number 60111B. Cat. No. V.2717.

Para-type: 11 more or less well preserved dorsal vertebrae and some fragments of the same. Field number 60111A. Cat. No. V.2718.

The two skeletons have been found with a distance about seven or eight meters. The paratype is badly weathered and many of the remains were unable to save in the field, while the type is better preserved. In both cases, either the missing bones were destroyed by erosion or still left unearthed in the field.

Horizon and Locality: Upper Permian from the vicinity of Lishenglen, Paote N. W. Shansi.

Diagnosis: Size fairly large. Vertebrae deeply amphycoelous with strongly developed and transversally oriented post- and prezygapophysis. Intercentrum well developed in the dorsal vertebrae. Hypantrum and hyposphene weak but recognizable. Sacrum six in number. Scapula narrow, long and slender. Coracoid and precoracoid co-ossified. Clavicle strong. Humerus large with the both ends strongly twisted, proximal end being very much expanded and no entepicondylar foramen. Ilium not inclined anterior-wards and with the upper border straight, the upper border of the ilium being decidely broader than the width of lower border, pubis and ischium together.

Vertebrae: Since both the vertebrae of the type and the para-type are more or less disturbed after the excavation was made, we are not absolutely sure concerning the actual sequence of the vertebrae in the column except those in consecutive series. The block with five vertebrae (fig. 2) represents certainly the part immediately before the sacrum (fig. 3) but failed to get the actual connection. The others are arranged according to the structure, probably four neck, four anterior dorsal and one caudal, the absolute position of which are not quite sure (Pl. II). In the paratype, the block with seven vertebrae are most probably posterior middle dorsals and the four mostly isolated ones the anterior dorsal and one caudal (fig. 4), the absolute position of which are likewisely rather subjective.

The four isolated **neck vertebrae** of the 60111B are all incomplete. The first one is only represented by the part around the neural canal. The second and the third are represented by the centrum only, while the supposed fourth with the centrum and the right side partly preserved. This is probably the posterior neck or even the anterior dorsal one. All the preserved centra are comparatively short and deeply amphycoelous with the ventral side rather broad. They are only weakly constricted. The third one is somewhat keeled on the ventral side.

The following four isolated anterior dorsal vertebrae (the first two are in natural connection and the last one with the part of the centrum of the following one preserved) are better preserved. The first two in natural connection represent most probably the 11th to 12th or 12th to 13th presacral vertebrae. They are strongly distorted but the general structures are mostly clearly indicated. In the anterior view the "hypantrum" is weakly indicated. Between it and the neural canal there is a weakly developed pyrami-like development which not found in any of the related forms. This structure is, however, missing in the fourth isolated vertebra. The centrum of the anterior dorsals is only weakly compressed. In all these vertebrae the facet of the diapophysis is mostly

clearly shown which is narrow and long and rather obliquely oriented. In the last one it becomes decidely shorter showing that it belongs to the rather posterior part of the dorsal column.

The block containing five more or less complete vertebrae is probably immediately before the sacrum although no sure actual connection can be made out. It is possible that the last broken vertebra may represent the last presacral vertebra. If so, it represents probably the last five presacral vertebrae 16—20. In all the more complete preceding ones the spina dorsalis is broken. The post- and prediapophysis are heavily developed and two of the left side and three of the right side are in actual connection. The diapophysis is short with elongated oval facet. The ventral side of the centrum of the last three ones is less compressed, while that of the preceding ones is distinctly developed as a sharp rigde, intercentrum is well preserved in a few of them.

The vertebrae of the paratype complements considerably those of the type specimens. The first one is much damaged and probably the number 11th or 12th presacral vertebra. Although the centrum of the next one is damaged, but it is certainly sharply compressed. The first one in connection has the centrum broken. The spina dorsalis of the second one is well preserved. It is comparatively long and slender. The post- and the prezygapophysis of the two vertebrae of the left side is well preserved. The isolated vertebra is doubtfully considered as the one posterior to the described two. Its centrum is rather short. The block containing seven vertebrae is much displaced but the general characters are mostly well indicated. In all of them the ventral side of the centrum is sharply compressed with well developed intercentrum, so that it is probable that they may represent the 11th to 17th posterior dorsal vertebrae. In most of them the spina dorsalis is well preserved. They are comparatively long and slender with more or less sharply keeled anterior and posterior edge. The distal end is only moderately thickened. The jointed part of the pre- and postzygapophysis of the right side are mostly well shown on the right side.

The most interesting part of the skeleton is the **sacrum** of the type specimen shown in figure 3. The centrum of the first sacral is broken as indicated by the first sacral rib. In this case, the whole sacrum is certainly composed by six vertebrae instead four of most of the pareiasaurs. It is probably that one vertebra may be missing between the anterior sacrum and the block immediately before as described above.

The centrum of the sacrum is narrow but not compressed as the last two of the above described block before this complex. It decreases in size but not in absolute length posteriorly, so that the posterior ones look elongated. They are firmly connected together. The spina dorsalis of the sacral 2—4 is for most part preserved. They are rather long but fairly thin and compressed. The sacral rib is for most part preserved in the left side. The first two are in perfect connection with the anterior part of the upper border of the left ilium. The same is for the one before last one. Those of the middle two are broken but can be surely traced. Total length of the whole sacrum is about 260 mm. The whole sacrum is moderately curved as seen from the side.

The **caudal vertebrae** are only represented by two, one of the type and the other of the paratype. They are too imperfect for a detailed description.

On the whole the two sets of the vertebrae are agree in general features and certainly pertaining to the same species. Since they are not sufficiently known we are not

sure about the number of the vertebrae of each part of the column except the sacrum. It is, however, very probably that there about 20 presacral vertebrae as in most of the pareiasaurs of which 5 or more belong to the neck. The well development of the intercentrum and the increase number of the sacral vertebrae suggest the more primitiveness of the animal, while the strong development of the post- and prezygapophysis are common characters usually observed in most of the pareiasaurs. The less thickened spinal dorsalis may suggest the poor development of the dermal armour.

In both the type and the paratype, there are a number of fragments which are certainly those of the vertebrae but failed to get the real connection. There are three better preserved spina dorsalis of 60111B and one of 60111A with the postzygapophysis well preserved. They indicate further vertebrae not described above.

Among the fragments of 60111B, a few fragments may indicate the **ribs** of the dorsal region.

The **scapula** of both sides are preserved. The right one is complete only the distal end is somewhat incomplete. The left one is also nearly complete but the proximal end is broken and adhering to the precoracoid and coracoid. Its distal end is somewhat damaged. The scapula is straight and narrow with the both ends only slightly expanded. In these features it differs very much from the scapula of the known pareiasaurs. It is moderately thick especially near the proximal end. The acromion process is very weakly developed and low in position. The distal end of the right one is not quite normal and we doubt whether there is a cartilagious suprascapula present. Total length: right, 650 mm, left, 640 mm (estimated); breadth across the acromion 160 mm (right); breadth of the distal end 130 mm (right); transversal breadth near the proximal end, 71 mm (right).

Coracoid and precoracoid are only represented by the left side. They are co-ossified with the proximal end of the left scapula. The lower border of both is partly damaged. The sutures between the two bones as well as with the scapula can be faintly traced as indicated in figure 7. The coracoid foramen is fairly large and situated very marginal near the scapula border. The glenoid surface formed by the scapula and the coracoid is shallow and wide. Maximum anterior posterior length of both precoracoid and coracoid, 270 mm.

The both clavicles are present. The left one is nearly complete while that of the right one with the upper part in connection with the scapula is broken. It is very similar in structure to that of other pareiasaurs but looks more robust. End to end straight length 495 mm. It is moderately curved.

Unfortunately there is no trace of the presence of interclavicle and cleithrum for getting a complete restoration of the pectoral girdle. Nevertheless, the putting together of all the preserved elements of this part of skeleton gives a fairly reliable shape as showing in plate I and II.

Humerus: The left humerus is almost complete while that of the right is badly damaged, being only preserved by the proximal part. The following description is based chiefly upon the left one.

It is an extremely large bone, total length about 540 mm (the same of *Pareiasaurus serridens,* measured from the figure ca. 450 mm and of *Pareiasuchus péringueyi,* 345 mm and of *Propappus rogersi,* 267 mm). The proximal end is strongly expanded. Maximum

breadth, 290 mm (the same measurement of the three named genera, ca. 259 mm; 184 mm and 178 mm respectively). The distal end is less expanded. Maximum breadth, 250 mm (the same measurement of the three named genera, 230 mm; 140 mm and 175 mm respectively). The middle part is strongly constricted, 58×75 mm in diameter.

The both ends are rather strongly rotated about 40 degrees, much less than that of *Pareiasaurus serridens* and more than that of *Propappus rogersi.* Along the proximal end at the place of the condyle there is a prominent groove much like that of *Propappus rogersi.* As suggest by Broom, it is most probably that it had thick pad of cartilage. The shape of the delto-pectoral crest is also similarly formed as in the case of the named species with a distinct knob too. It extends very much downwards. There is no ectepicondylar foramen but a groove of it is clearly recognizable which is located rather high. The entepicondylar foramen is also lost. It is different from that of *Propappus rogersi, Pareiasuchus péringueyi* and *Pareiasaurus serridens* of which this foramen is well developed. The articulation surface of radius and ulna is well separated and robust.

Pelvic girdle: Both sides of the pelvic girdle are present, the left side is almost complete while that of the right one is less, the lower border of the pubis and ischium being somewhat damaged. The pelvic girdle is a single piece of bone with the three elements completely co-ossified as in the other pareiasaurs. The pelvic girdle of our form is especially characterized by the comparative length of the upper border of the ilium which exceeds considerably the lower border length of pubis and ischium together.

Length of the upper border of the ilium, 320 mm, left, 325 mm, right (the same of *Pareiasaurus serridens,* 367 mm; *Pareiasuchus péringueyi,* 225 mm and *Propappus rogersi,* 190 mm). The length of the lower border of pubis and ischium, 280 mm, left. Maximum length of the pelvic girdle 550 mm (in *Pareiasaurus serridens* 615 mm). Width of the accetabulum, 170 mm, left (the same of *Pareiasaurus serridens,* 155 mm, *Pareiasuchus péringueyi* 97 mm and *Propappus rogersi* 115 mm).

The **ilium** takes most part of the pelvic girdle. Its upper border is perfect straight, and not inclined forwards, not as in the case of *Pareiasaurus serridens* and *Pareiasuchus péringueyi,* but much like that of *Propappus rogersi.* Its relative length of the upper border is perhaps responsible for the increasing number of the sacrum. Looking in dorsal aspect, the first and the second sacral ribs of the left side, co-ossified near the ilium articular surface, are in well jointed manner with the anterior part of the ilium of the left side. The trace of the proximal part of the third and the forth ribs are still recognizable in the left ilium. Much better is the fifth one which is almost complete. In the right side they are not so well preserved but such arrangement can be traced in most satisfactory manner. The ilium constricts suddenly above the acetabulum but start to expand again a short distance above the acetabulum. In both sides of the pelvic girdle the sutures between the ilium, pubis and the ischium can be traced with much certainty as indicated in given figure 9.

The acetabulum itself is well rounded and moderately deep with the upper border slightly overhanging.

The **pubis** is relatively small and takes only a little part for the acetabulum. The right one is partly damaged. The pubic foramen is small but clear visible. Its anterior lower part of the left is also partly broken.

The **ischium** is rather peculiarly shaped. Judging from the broken breakage of the

both sides, it seems that there is a short pointed tip of the ischium, quite different from that of *Pareiasaurus serridens* and *Propappus rogersi* and much like that of *Pareiasuchus péringueyi.*

Since there is a little distortion of the sarcal part of the skeleton and the right pelvic girdle is not quite completely preserved (the bone of the right side is also somewhat thinner), it is not possible to get the symphysal part in actual connection. On the whole there is no doubt in referring the pelvic girdle to the family Pareiasauridae but certainly characterized by a number of peculiar features, such as the long upper ilium border and the pointed ischium. In consideration of the absence of the forewards inclination of the upper border of the ilium and the perfect straightness of its upper border, our form looks much closer to the *Propappus* rather to other genera.

There is no sure indication of the presence of the dermal scutes, although some of the fragmentary bone may be proved of such. Probably one animal is also covered by long scutes as the other pareiasaurs.

DISCUSSION

Although there is no cranial element present and the skeleton of the postcranial bones are much imperfectly preserved, but the characteristic part of the bones at disposal are sufficient to make a reliable determination. The peculiar vertebrae with the almost transversally oriented zygapophysis and the presence of the intercentrum, the characteristic anterior limbs, especially the humerus and first of all the pelvic girdle so closely similar to the genera of the pareiasauris, it is perfectly clear that our form has to be placed under the family Pareiasauridae of the order Pareiasauria under the supra-order Cotylosauria.

Nevertheless, the present form is characterized by a series of features as described above which failed to identify exactly with any of the known genus. Since there is no skull and teeth preserved in the Chinese form, it is impossible to compare exactly with the eleven genera list bibliography of Haughton and Brink (1954) based chiefly on the structure of skull and teeth. But many of them, such as *Anthodon, Brachypareia, Bradysaurus, Dolichopareia, Embrithosaurus, Nanoparia* and *Nochelesaurus,* etc., can be excluded either by their large or small size. The genera *Pareiasaurus* and *Pareiasuchus* can also be discarded by the shape of the ilium. The closest one is the genus *Propappus* but differs from that of our form also by the shape of the pelvic girdle and the humerus.

Comparing with the form other than those of S. Africa, the *Scutosaurus* of U. S. S. R. is certainly the closest one. It resembles not only in general shape but also close in size. But our form is certainly much larger, the humerus figure by Hartmann-Weinberg (1937) has a length only 300 mm, and it is apparently more flat and less rotated of the both ends. Furthermore the sacrum of the Chinese form is composed of six vertebrae and the shape of the pelvic girdle is also quite different.

It is therefore very probable that we have to deal with a new form of the pareiasaurs for which the name *Shihtienfenia permica,* new genus and new species, is proposed. Its diagnosis is already given above. In view of the increasing number of the sacral vertebra, the very long and straight upper border of the ilium, and the absence of the entepiccondylar foramen of the humerus, etc., of the Chinese form, it very likely that it represents a new family of the order of Pareiasauria. As already pointed out it is closely comparable with the South African *Propappus* and the Russian *Scutosaurus.* In using

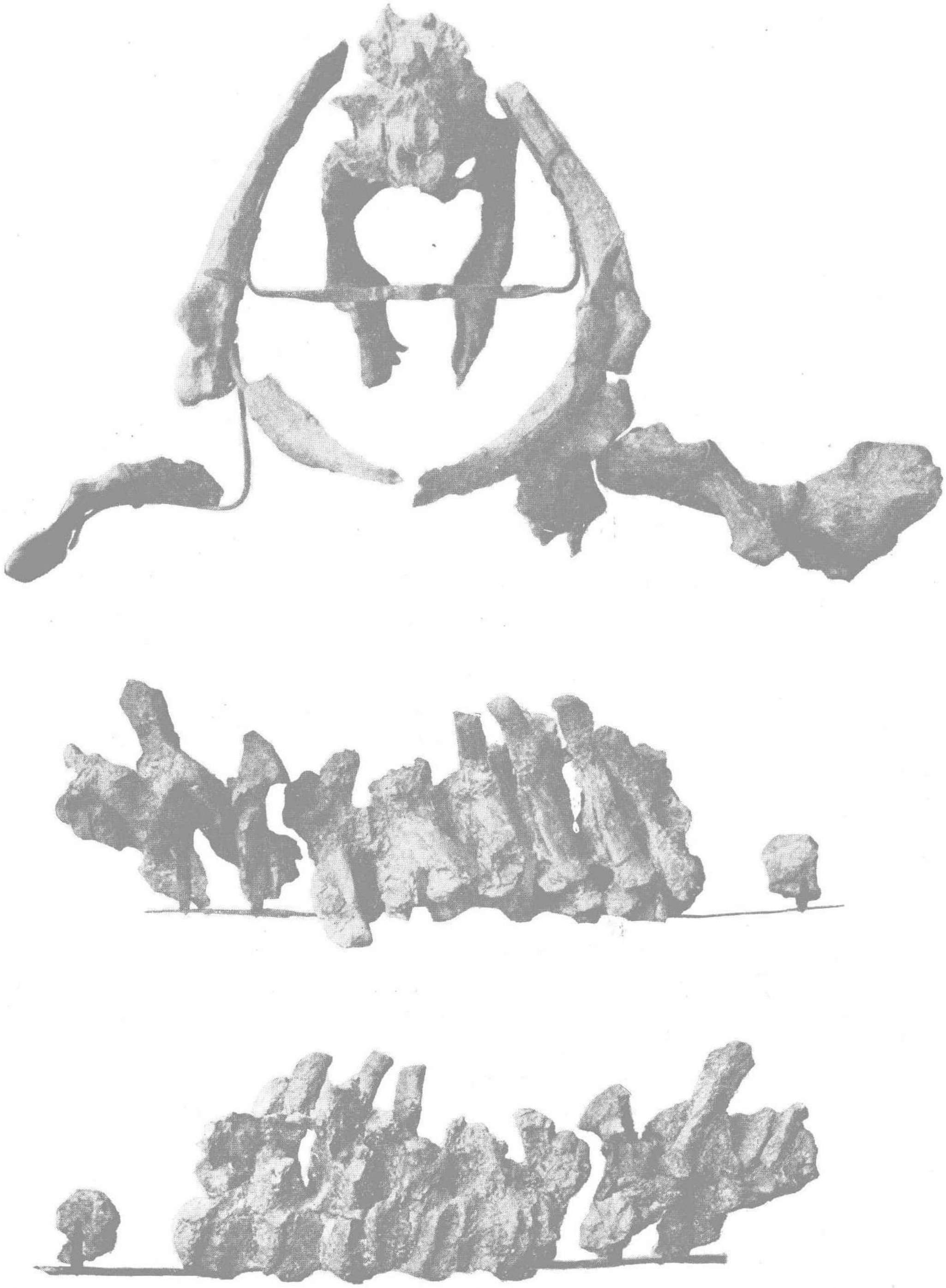
the literatures chiefly by Broom himself, we do not think it is all right to consider the genus *Propappus* as a synonym of *Pareiasaurus* by the shape of the pelvic girdle, because they are certainly different in their original description (1903 and 1912).

Shihtienfenia permica is the first record of Pareiasauria in China. As noted above, it was derived from top of the lower Shihtienfeng Series. The discovery of this interesting form indicates that the geological age of which the new form derived is certainly Upper Permian. This conclusion is in accordance with the same subject reached by H. H. Lee from the point of view of paleobotany (Lee, 1963, 1963A). It must be noted, however, that since the fossils of vertebrate described in the present paper is derived from the lower part of the series and the other new fossiliferous zone from Lincheyue (may from the upper part of the Shihtienfeng Series) is so poorly known, we are not quite sure at least at present that the whole series should be grouped in the upper Permian. As soon as there is no true *Lystrosaurus* or its related forms found in Shansi we prefer to let the problem unsettled at present.

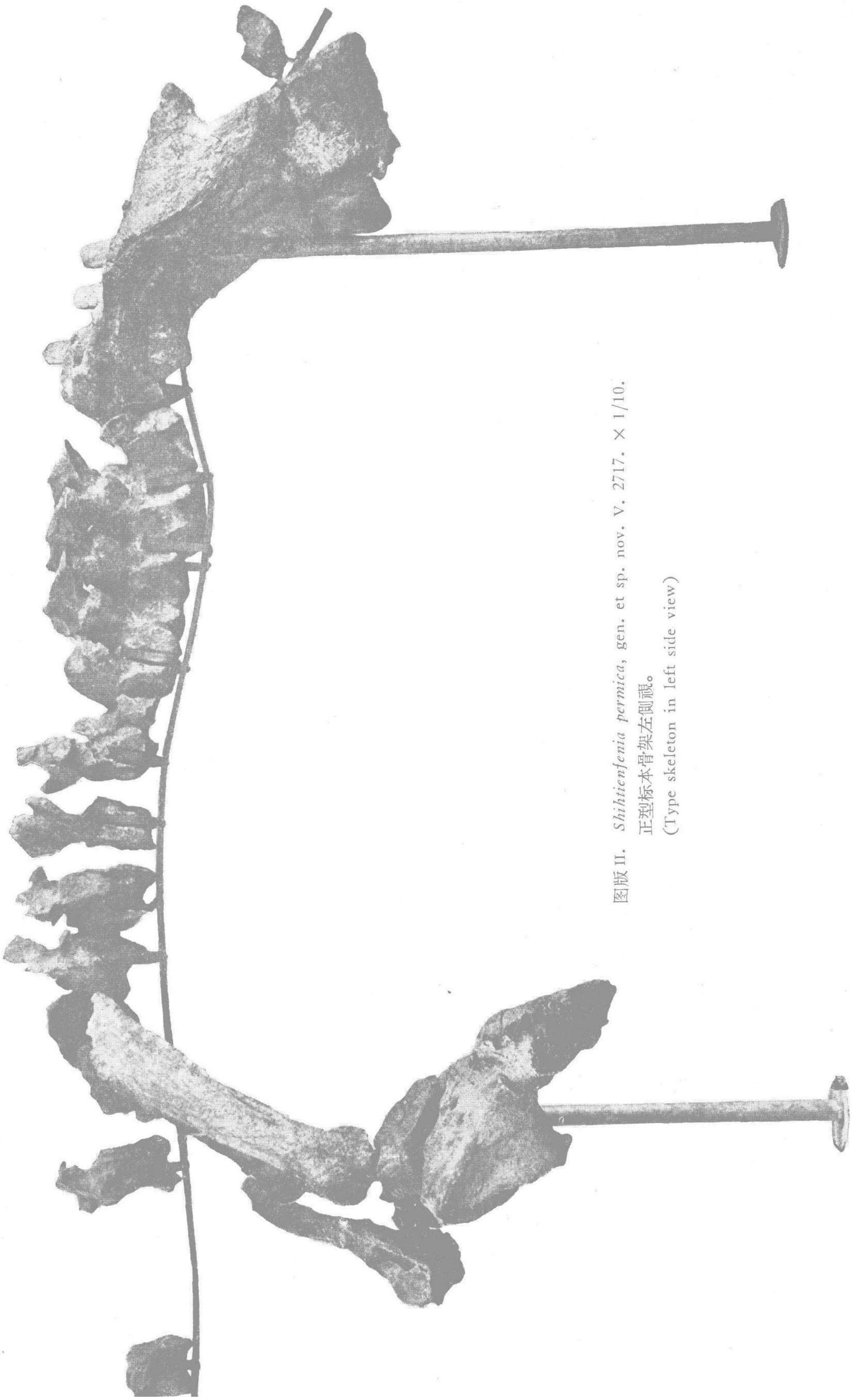
With the study of the present form and other researches made in the Permo-Triassic stratigraphy we are able to locate at least six vertebrate horizons, all closely comparable with those of S. Africa and U. S. S. R. It may be summarized in the following manner:

	S. Africa	U. S. S. R.	China
Triassic	Cave sandstone, Red Beds		*Lufengosaurus* (with *Bienotherium*)
	Ictidosaurian Zone		
	Molteno Beds		
	Cynognathus Zone B	Zone VII	
	Cynognathus Zone A (with *Erythrosuchus*)	Zone VI	*Sinokannemeyeria* (with *Shansisuchus*)
	Procolophon Zone		*Ordosiodon* (Lincheyue)
	Lystrosaurus Zone	Zone V	*Lystrosaurus* (with *Chasmatosaurus*)
Permian	*Cisticephalus* Zone	Zone IV B (with *Scutosaurus*)	*Shihtienfenia*
	Endothiodon Zone	Zone IV A	
	Tapinocephalus Zone	Zone III	*Labyrinthodonts*
		Zone II	
		Zone I	

With the exception of the *Lufengosaurus* fauna of Yunnan and the *Sinokannemeyeria* fauna of Shansi (perhaps also the *Lystrosaurus* and *Chasmatosaurus* of Sinkiang), all the others are still rather poorly known. The present study denotes very much the hope that the continental Permian of China is just so rich in vertebrate remains as those of the Triassic.



图版 I. *Shihtienfenia permica*, gen. et sp. nov. V. 2717, V. 2718. ×1/10
上，正型标本骨架前視；中，副型标本骨架左侧視；下，副型标本骨架右侧視。
(Upper, anterior view of type skeleton; middle, left side view of paratype skeleton; lower, right side view of paratype skeleton)



图版 II. *Shihtienfenia permica*, gen. et sp. nov. V. 2717. × 1/10.
正型标本骨架左側視。
(Type skeleton in left side view)